Teachers-as-learners: The role of a multimedia professional development program in changing classroom practice

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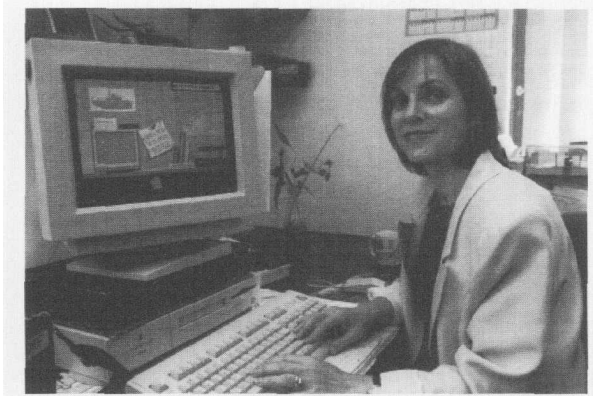
Abstract

This paper describes a professional development program which involved the use of a multimedia package to develop teachers' understanding of a constructivist epistemology in science education. The professional development program put the teachers in the role of learners in an attempt to enhance epistemological change and subsequently influence their use of the multimedia program and constructivist teaching approaches in their classrooms. The multimedia program, *Birds of Antarctica*, an interactive program, was developed using constructivist principles. During the workshop, and subsequently in school classrooms, video and audio recordings were made of teachers' and students' interactions with the program and their reactions to the constructivist-oriented learning environment. The results of the study suggest that teachers who engage themselves as learners in a professional development program have greater opportunities to bring about the successful implementation of new ideas in the science classroom.



Dr Dorit Maor is a Research Fellow at the Science and Mathematics Education Centre, Curtin Universtiy of Technology. Her current research focuses on the use of interactive multimedia to enhance students' inquiry and higher-level thinking skills in science classrooms, and use of the World Wide Web as a tool to promote and study the development of teachers in communities of learners using reflective and collaborative learning. Dorit previously taught high school biology in Israel. (Photo: Hans Versluis)

The study described in this paper investigated the effect of a series of professional development workshops on engaging teachers in epistemological transformation and subsequently on their use of a multimedia program and constructivist-oriented teaching approaches in their classrooms (see Maor & Taylor, 1995). Providing teachers with a novel constructivist-oriented technological tool and expecting them to use it successfully in a specific way in their teaching is an unreasonable expectation. Loucks-Horsley (1998, p. 1) claims when trying to create systematic reform "professional development is one of the critical links in this chain, one that can take purposes and policies and influence student learning through its impact on teaching." To inspire any fundamental change in the classroom, teacher learning is essential.

Changing teachers' epistemologies through professional development

A problem facing education today is the resilient nature of beliefs that shape teachers' classroom practices, and the need to provide teachers with opportunities to discuss and reflect critically on their pedagogies. Maor & Taylor (1995) described the highly influential role of teachers' epistemologies in facilitating students' development of higher-level thinking skills, particularly amongst a small minority of teachers who already held constructivist-oriented epistemologies. These teachers emphasised constructivist-oriented practices of social interactions and negotiations in inquiry-based learning environments in their classrooms. Salomon (1996, p.1) suggested that for a teacher to be an "autonomous, confident, widely knowledgeable professional, and a team player" s/he needs in-depth professional training.

Although there is an awareness of the social role of learning, research on teachers' beliefs has shown most teachers have transmission-type epistemologies which resist change in the classroom. Studies of constructivist-oriented approaches to teaching and learning have substantiated the importance of changing the role of the teacher in the learning process (e.g., Hand, Lovejoy, & Balaam, 1991; Treagust, Duit, & Fraser, 1996). Since a constructivist-oriented teaching pedagogy seems appropriate for realising the goals of inquiry-based curricula, the workshop included a focus on changes in teachers' epistemologies. The work-

shop provided opportunities for teachers-as-learners to reflect on their progress through a software program, to support the successful use of computers, and to promote problem solving and thinking skills amongst their students.

Teachers and computer technology

The use of computers can enhance cognitive powers of students during thinking, problem solving and learning (Jonassen & Reeves, 1996). However, for this to happen, teachers need to understand the technology and shift the locus of control to their students. Yet, many teachers are still reluctant to integrate computers into their classroom. They need to improve significantly their knowledge and skills if they are to provide adequate support and guidance for students using information technologies. Some schools offer teachers portable computers to help them overcome their fear of technology (Ainley & Pratt, 1995).

The role of a constructivist-oriented multimedia program

The Interactive Multimedia (IMM) program used by the teachers in the workshop used a constructivist-oriented view of learning with the intention of creating a 'rich' environment for the students (Maor & Phillips, 1996). To produce this constructivist-oriented learning environment the IMM package:

- simulated authentic learning environments;
- provided multiple representations of data;
- engaged students in personal constructions of reality;
- enabled students to generate their own questions and investigations; and
- promoted social negotiations between students including providing them with opportunities to reflect upon real-life issues.

Harper and Hedberg (1997) suggested the shift from behaviourally designed software to cognitive and constructivist approaches requires multimedia programs which involve real-world contexts and provide practice with authentic tasks. Teachers need to facilitate the use of such programs by allowing time for reflection, debriefing sessions and whole-class sharing of ideas and experiences to promote metacognition (Galligan, 1995).

Research design

A series of workshops was conducted with secondary school science and mathematics teachers. These workshops were designed to guide teachers in promoting a constructivist-oriented approach to teaching and learning when using computers to support their students' development of higher-level thinking skills. The aim was to induce change in individual teachers' epistemologies and subsequently in their pedagogical practices and in their students' learning. How the teachers responded to the changes and whether or not those changes endured were key factors addressed in this study.

Planning the teachers' professional development workshops

The aim of the workshops was to provide experience of an IMM for teachers-as-learners through several activities including:

- using the IMM program;
- using constructivist-oriented epistemologies to support the higher-level learning for students; and
- generating questions and investigations based on the IMM package.

The workshops facilitated teachers' use of computers in science classrooms, while enhancing their understandings of, and ability to use, personal and social constructivist approaches to teaching and learning in the IMM learning environment.

The workshops consisted of three three-hour sessions conducted over three weeks with one session per week. Follow-up in individual classrooms provided information about the effect of the workshop on the teachers' role in the classroom. Erickson's (1998) particular description was used to analyse the data. Particular description consists of narrative reporting of detailed evidence concerning the actions and beliefs of sets of persons in the setting that is being investigated (Erickson, 1998).

Results

Qualitative data obtained from workshop discussions, participants' journals and interviews with teachers provided additional insights with which to evaluate the influence of the workshop on teachers' pedagogies. Data are presented as general assertions as part of interpretive analysis (Erickson, 1986; 1998). Specifically, data were gathered from three high school science teachers: Mark, Julie and Anne.

Three teachers who participated in the workshops were followed in an attempt to understand the extent to which the workshop influenced the teacher's role in the classroom. The first teacher, Mark, provided observations of his students' experiences with the program. In Julie's class I taught students and conducted research with the help of a research assistant, whilst Anne, the third teacher, implemented the program independently of us.

Classroom implementation

Relevance, motivation and an inquiry-based learning approach were, for Mark, the criteria which helped him make decisions about the use of the program in his classroom.

> ...the use of 'real life' data and data analysis through inquiry learning as proposed by *Birds of Antarctica* package addresses the issues of relevance, motivation and scientific method. Through the use of such packages I hope I can further move my class towards student centred learning with my role continuing the change from teacher to guide (Mark, Journal).

Immediately after the workshops, Mark implemented action research with his Year 10 biology students. The class comprised 31 students of average to low ability with a limited background in environmental biology. They worked in pairs. There were three sessions where computers were used: two sessions of 45 minutes and one session of 90 minutes. Students engaged in self-reflection assessment at the end of each session.

Initially, Mark expressed some frustration with the IMM program, but this was reduced with an updated version of the program which overcame most technical problems. He felt students reached a reasonable level of competency, but he needed more time to pursue inquiry-based learning with his students.

Group work was strongly encouraged and practised in the teacher workshop, and Mark also had the opportunity to implement this strategy in the classroom. Mark was pleased he had asked students to take ownership of their questions and investigations. He then suggested that students, working in pairs, present their questions and demonstrate their investigation to the whole class on a display panel.

> The group work [for presentation] was a great success and highlights the need for more regular use of this [constructivist] style of teaching (Mark, Journal).

To promote inquiry-based learning and provide a means of assessing their development of higher-level thinking skills, students were asked to conduct their own investigation during their interaction with the IMM program. Mark suggested he would attempt a move towards a more constructivist-oriented, student-centred approach to learning which would require more reflection from the students. He also gave students opportunities to say how they felt about how the class was going.

> [I intend] to take the class into a different style of learning ...it also initiated further discussion within the classroom on the nature of learning (Mark, Interview).

This was a significant challenge for Mark, as he was aware the students were still programmed into looking for facts to learn. The need for factual knowledge was strong and the transition to inquiry-based learning requires a mind shift for both teacher and students. Such a shift could be facilitated by constructivist-oriented multimedia using real data and open-ended investigations. This appealed to Mark as a science teacher who tried to put students' work into an authentic context:

> I actually told them to put themselves in a position where they were a scientist in one of these boats and what sort of information would they like to collect and how would they like to go about collecting it and what sort of questions would they like to ask (Mark, Interview).

Mark was keen for student pairs to present their work to the class:

> I think it's good for them to have that, I like kids to present to a class, it gives some justification to what they've done in their own minds as well I think, some value to it. ... It's good for the other students to hear it in the voice of their peers (Mark, Interview).

Mark noted a student's comment that "group work helps each other understand." He believes students worked together to reach an answer with interactions between students enabling them to share knowledge with their partners. Mark suggested "the benefits of this interaction was one of the highlights of this trial" (Mark, Journal).

Assertion 1: Experiences of teachers-as-learners encourage teachers to promote group work and to discuss the nature of learning with their students.

Classroom study

A second set of data was provided by Julie, who participated in the workshop and allowed us to conduct research with her students. In Julie's class, I acted as a facilitator with the help of a research assistant. A "safe simulation" (Hargreaves, 1994) in which to conduct the research was created by Julie who actively engaged herself, along with the students, in the use of the program, while I conducted the study.

Julie believed her students would value the opportunity created by this research project and participated in the project because she wanted her science students to use IMM. She also wanted something useful "but that did not have to end in assessment, but which could be used for assessment if desired." She was aware her science students did not have a lot of access to biological information on the computer.

While Julie thought the program would have a technological impact, it was also relevant for biology students in Years 10, 11 and 12. She was unsure of the best ways to use technology or how to bring about its integration in the science classroom. She emphasised:

> I had been looking for an interactive technology program that was not looking at science content (Julie, Interview).

The value of interaction with the program, according to Julie, is firstly to experience "biological information in a technological setting." Secondly, students experienced an unstructured situation for two weeks, "which was a very different learning environment" from their normal science classes. In this learning environment they were solving problems by searching for information using an inquiry-based design model.

Julie found learning and teaching processes had changed during the two week interaction with the program,

especially the degree of involvement of the teacher:

> Students worked with minimal teacher supervision, they became more motivated, they were able to ask questions or conduct investigations (Julie, Interview).

Students working in pairs enjoyed the opportunity to discuss problems and to help each other answer questions. Julie reported that students exhibited more control over their learning while deeply engaged in their tasks:

> They walked into the classroom, into their computing room and they were totally focused on the task, from go to whoa, and that was for two weeks, so they were very focused overall, I felt (Julie, Interview).

She thought the computer program was excellent for developing scientific process skills because it was "so quick.... so much flexibility and so much data." She further suggested she does not want her ideas to dominate students' thinking but for them to be "exploring on their own and being more creative on their own." One of the outcomes of the workshops for Julie was her greater interest in integrating multimedia programs into her science classroom and particularly programs which involved students in inquiry-based learning and helped them develop their skills in scientific investigation.

Assertion 2: Innovative teachers may be interested in providing their students with constructivist-oriented multimedia programs which provide opportunities for inquiry-based learning in the science classroom.

Away from the professional development

The last case study is that of Anne, a science teacher who participated in the workshop then implemented the program in her classroom without any external support. At a time when I was unable to visit the school, Anne introduced the program to her class of 16 at an all-girls school. Although she experienced the program as a learner in the teachers' workshop, Anne created a different work pattern with her students.

The most obvious difference from the workshop pattern was that students worked individually on the program, despite Anne having worked with a partner in the teachers' workshop. She intended to challenge her students individually to observe how they worked. Students were also asked to follow closely the curriculum material designed to guide them in using the program. They were not encouraged to explore on their own. In this sense, Anne used a very instructivist-oriented approach while using the program, and although the curriculum material was only a suggested activity during the professional development program she followed it very closely in the classroom. Eventually, students started to answer questions and began to engage in higher-level tasks as they investigated by themselves. Anne described to me some of the difficulties in using the curriculum material:

> OK, this is where it just started dealing with some of the biological material, some of the birds themselves, rather than the temperature and climatic conditions.... so that students just started playing around with the ideas, trying to correlate different things. Then I said go on to one of the more difficult questions, and go investigate it yourself (Anne, Interview).

Anne encouraged students to select different questions from the guided tour and noticed most of them constructed their investigation using only one variable, and that they all wanted to do only a bar graph. She concluded they had a lot of trouble carrying out an investigation with more than one variable.

Evidence from Anne's classroom suggested that, although she participated in the professional development program, there was no change in her epistemology in relation to her classroom practice. She continued to work with her students in a didactic way. Students worked individually, and there was no discussion amongst them about their investigations. This outcome supports the notion of the resilience for change among teachers which led to the initial design of the professional development.

Assertion 3: After participating in a professional development workshop, a teacher may need further support to implement a constructivist-oriented program successfully.

Discussion

This study, which looked at teacher development in terms of gaining an understanding of a constructivist-oriented epistemology, may be a step towards solving some of the problems associated with the use of IT in schools. In this professional development program, teachers were positioned as learners in a new situation to engage them in epistemological change. This approach is supported by Salomon (1996), who suggested that teachers need to experience a novel learning environment as learners themselves to implement changes in their teaching. The professional development program also attempted to empower teachers in the use of the computer as a cognitive tool (see Jonassen and Reeves, 1996).

This investigation focused on teachers who used an IMM program and a constructivist-oriented theory of learning. The results underline the need to provide teachers with a novel learning situation to overcome their unfamiliarity with new technologies.

Issues that emerged in this interpretive study can contribute to improved design of professional development programs aimed at broadening the role of the teacher in IMM learning environments. As teachers had, themselves, experienced frustrations and the joys of working for the first time with the IMM program, *Birds of Antarctica* (http://

www.curtin.edu.au/curtin/dept/smec/staff/ maor/boa.html), they were better able to understand some of the difficulties their students may encounter. The issues from the study relate to the value of discussions between students and facilitator, the need to create opportunities for reflection, and future support for the teachers.

Teachers' discussions with students during classroom activities emerged as an important issue from the professional development program. Experienced teacher-learners successfully modelled strategies used in the professional development program when they promoted discussion and teamwork among students by discussing reflections of their own learning and the nature of learning. For some teachers, this could represent an important epistemological change.

Participating teachers showed great interest in providing their students with the IMM, because it provided students with opportunities for inquiry-based learning. They became more aware of an inquiry-based learning approach and tended to implement it in their classroom. Classroom observations confirmed students whose teachers attended the workshop used the IMM program with minimal teacher supervision, became more motivated, and were able to pose questions and conduct investigations. This change in the classroom learning environment suggests a change in teachers' epistemologies associated with their participation in the professional development program.

Classroom observations also indicated teachers chose different ways to present the multimedia program to their classes. For example, one teacher asked students to work individually and with no peer support during their interaction with the program, another teacher modelled the workshop in the classroom and encouraged group work, whilst another changed aspects of her classroom practice and applied new ideas to this setting. However, regardless of the ways in which teachers presented the multimedia, it was apparent they needed further support to implement this constructivist-oriented program successfully after the professional development workshop. This view is shared by Ainely and Pratt (1995) who recommend that professional development programs be organised so that facilitators can work alongside teachers in the classroom to help teachers overcome anxieties associated with new experiences.

There is some evidence of a link between teachers-as-learners and teachers-as-practitioners in their classrooms. In the workshop, teachers worked in a range of ways; some worked in small groups with a high level of interaction, whilst others chose to work independently without much peer support. Teachers were encouraged to work collaboratively, to engage in discussion, to reflect on their learning and to address the problems associated with the technical aspects of using the multimedia program and with the difficult concept of inquiry-based learning. This created a small but important change in a community of teachers and, subsequently, in the professional culture of teachers (Hargreaves, 1994). Similarly, in their own classrooms a range of implementation strategies was evident, ranging from a highly constructivist-oriented learning environment to more didactic teaching. This indicates that teachers need constantly to be engaged in negotiation and interactions with either their peers or other educators after the workshop. This approach is strongly recommended by Hargreaves (1994) who recognises the need for teachers' emotional understandings through sharing experiences and relationships with others. Fostering change in the classroom needs to focus on professional development starting with the teacher.

Conclusions

The results of this study indicate that teachers preferred working co-operatively to overcome technical problems, that they engaged in discussions and reflections in order to solve scientific problems and they needed further support to attend to their students' needs when using a constuctivist-oriented multimedia program in the classroom. In the present study, teachers were given the opportunity to be a learner in novel learning situation. The teachers' experiences as learners provided them with a better understanding of the learning process and helped them model teaching pedagogies appropriate for students working in a constructivist-oriented inquiry-based multimedia learning environment.

This study suggests that teamwork, clear instructions for working with the program and familiarity with the multimedia interface were pre-conditions for successful inquiry-based learning. The study also indicates that placing teachers in the role of learners in a novel situation is a strategy which has the potential to bring about epistemological change among the teachers. It encourages them to use constructivist-oriented teaching and learning in the classroom, to engage their students in social constructivist learning, and to promote inquiry-based learning. Future professional development programs need to include classroom-based support for teachers implementing constructivist-oriented learning environments using IMM. This support needs to be provided during and after the completion of the workshops phase.

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